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Keywords

methods, assessing, regional, economic, impacts, defense, survey, activities

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Assessing the Regional Economic Impacts of Defense Activities: A Survey of Methods

Josselin Droff¹ and Alfredo R. Paloyo²

Abstract

Defense activities exercised in a specific region may alter the region's economic performance. An accurate assessment of the potential economic impacts of defense activities is a valuable undertaking to enable regional planners to prepare for changes. The variety in the methods (among others, input-output models, economic base models, Keynesian regional multipliers, fixed-effects estimators, and case-study approaches) inspired by geography, sociology, and political science can pose a dilemma. We detail the historical and theoretical background of each method, as well as select exemplary cases where these methods were applied. By examining old and "new" methods, we aim to construct a typology that could be valuable to all stakeholders. In this sense, defense economics can also contribute to the allied social sciences by outlining evaluation methods that may be applicable to other fields.

JEL: O18, R11, R15

Keywords: defense activities, public planning, regional-impact evaluation

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INTRODUCTION

In this survey, defense activities are broadly defined to pertain to all economic activities related to military matters. These include—but are not limited to—spending on military personnel and bases, defense equipment supplied by industries (both public and private), and other relevant spending (e.g., maintenance and other operating expenses). From a regional and economic perspective, defense activities are usually exogenous expenditures for regions and often occur regularly for extended periods. Although rather liberal and encompassing, such a general definition is also pragmatic in an ambitious survey covering various geographic, temporal, and methodological contexts.

The defense sector's size and influence have varied over time, depending on strategic, economic, and ideological considerations. Throughout history, the type of defense provided has changed and these changes have played a role in the process of regional development [Law 1983]. The US process of Base Realignments and Closures³ (BRACs) is among the most emblematic changes in a nation's defense strategy; it also illustrates the stakes involved in the assessment of its regional economic impact. But regional impacts may also be expected from the closure of plants related to the defense industry (e.g., the closure of a military shipbuilding company).

The reasons for closing military facilities are varied, but the typical primary objective is to save on costs. Other considerations concern changes in military priorities. For instance, many bases or facilities have simply lost their strategic importance as a consequence of the dissipation of the Cold War and the advent of the modern war, sometimes called “new war” [Kaldor 1999]. There are also new threats which are characteristically different from Cold War-era circumstances (e.g., asymmetric warfare, multipolar threats, terrorism, and regional conflicts). Plant closures in the defense industry are often the consequence of a decrease in military spending such as in the “peace dividends” period in the 1990s.

For a variety of reasons, defense activities in a particular region may affect the economic performance of the region itself and its periphery. Changes in these activities are a potential source of disruption for which a regional planner may want to prepare. An accurate assessment of the potential economic impacts of defense activities within a specific area is therefore an important undertaking. We contemplate a scenario where a public planner wants to assess the economic impact of defense activities. The heterogeneity in methods and in institutional settings amplifies the need for a broad-based survey that regional scientists and planners would find useful. In this sense, a survey can provide a preliminary framework for policymakers to identify which impact-evaluation methods work best under specific circumstances, cognizant of the relative costs and benefits of using one strategy over the others.

³ Base realignments involve the movement of military and civilian personnel among military facilities.

We identify two specific characteristics of the “defense activity–economic performance” nexus which raise public policy concerns. First, from a local perspective, it is useful to determine the extent to which a local economy’s economic performance hinges on the development of defense activities in the region. In many parts of the world, defense activities are often an important component of the local economy [Braddon 1995]. Consider, for example, closing a military base in an isolated region where it is the major employer (sometimes, even the exclusive employer, as in the case of *plateau d’Albion*, a former nuclear ballistic missile site in France). Second, quantifying the impact of defense activities is crucial when policymakers are contemplating an adjustment to the national defense strategy.

Despite the obvious need for credible and extensive information, past research has been limited in its coverage of outcome variables of interest and there is no consensus yet on the best approach to estimate costs and benefits. Thus far, the regional-economics literature has focused on estimating the impact of military bases on employment and income. Very few studies have expanded the scope to include other socioeconomic indicators, such as tax revenue and crime rates (but see, for instance, Paloyo et al. [2010a, 2010b]). Moreover, even if the regional scientist knows what to assess, the available methods are varied, including, among others, input–output models, economic base models, Keynesian regional multipliers, fixed-effects estimators, and many case-study approaches.

In this paper, we aim to construct a methods-based typology of the extant literature in regional economics, covering both old and “new” methods. The chronology of the evolution of methods in the literature is used as an organizing framework. We detail the historical and theoretical background of each method, as well as select exemplary cases where these methods were successfully or inappropriately applied. The latter may happen, for example, when researchers are applying the method beyond its limits and drawing conclusions not implied by the underlying model. Moreover, institutional limits may also play a role, such as the unavailability of required data or where administrative structures or boundaries make the application of a “turn-key model” impossible or misleading.

The paper is divided into five sections. The first three sections present the methods for assessing regional impacts of defense activities that have so far been dominant in the defense economics literature, i.e., input–output models (Section 1), economic-base models (Section 2), and regional Keynesian-multiplier models (Section 3). The subsequent section focuses on econometric regional modeling and its application to defense activities (Section 4). The final section presents regional case studies (Section 5). We conclude with some policy recommendations

suggested by results found in both the regional and the defense economics strands of the literature.⁴

1. INPUT-OUTPUT MODELS

Input-output models (IOMs) have been the workhorse models in the literature since the seminal works of Leontief [1936, 1951] and Isard [1951, 1960]. At the national or regional level, IOMs quantify the interdependencies between production and consumption among different sectors of the economy, thus making them particularly powerful tools for the study of the effects of demand-driven changes in the economy.

The so-called “technology matrix” in IOMs characterizes the linkages between the various sectors of a given economy. Such interdependencies are called backward linkages (or use of inputs) and forward linkages (or use of outputs). For example, agriculture has minimal backward linkages, since much of its input comes from the agricultural sector itself (e.g., the use of organic fertilizers or seeds). Forward linkages are significant in, for instance, the chemical industry, since its products are typically used further in the manufacturing process. The main assumption of IOMs is that any good or service in the economy is used for final consumption by (1) households or the government, (2) exported, or (3) employed as an input in the production of further goods and services in the economy (including the sector that produced it).

In a basic IOM, the economy is made up of $i = 1, 2, \dots, N$ branches, with each branch producing x_i units of a homogeneous good. Denote a_{ij} as the technical coefficient or the share of output from branch j that branch i needs to produce a single unit of x_i , with $j = 1, 2, \dots, N$. Each branch can sell its output either to other sectors to be used in further production or to be finally consumed (domestically or abroad as exports) by households or the government. Let final demand in the i^{th} sector be y_i . Then, we can write the accounting equality as

$$x_i = \sum_{j=1}^N a_{ij} x_j + y_i.$$

In matrix notation, the relationship above can be rewritten as follows:

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y} \Leftrightarrow \mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{y},$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse matrix [Miller and Blair 1985]. In the short run, with a constant technical coefficient, a variation in the exogenous demand (e.g., government expenditure, household consumption, or investment) will induce a variation in the total output calculated using the Leontief inverse matrix. Ultimately, we have, $k = \Delta \mathbf{x} / \Delta \mathbf{y}$, where k is the regional multiplier of the IOM [Martin 2010].

⁴ In addition, the supplementary material contains two tables. Table 1 is a summary of the strengths and weaknesses of the papers discussed in this survey while Table 2 collects the estimated multipliers from various models.

The early work of Moore and Petersen [1955] incorporated government expenditure (including defense expenditure) in an IOM for the state of Utah. Another study by Leontief and Hoffenberg [1963] estimated the effect of a change in the structure of final demand caused by military cutbacks on the industrial distribution of the labor force for the country as a whole, but the explicit analysis of military expenditure needed to wait for Leontief-type intra-national models, as they showed how the impact of defense cutbacks on the local economy might be measured.

The model of Leontief et al. [1965] rigorously measured “peace dividends” at the regional level, which are “the impact of the hypothetical shift from military to civilian demand not only in inter-industrial, but also in inter-regional terms.” In the model, the US was subdivided into 19 regions. The results showed that a decrease of about 20 percent in defense expenditure should be counterbalanced with an increase of about 1.8 percent in nonmilitary demand. The model presented an illustrated map of the regions most affected in terms of both employment and income (the first three “impacted built regions” were California, “Colorado–New Mexico,” and “Arizona–Nevada–Utah”).

IOMs have also been developed to explicitly study the regional effects of defense expenditures. A more localized study was conducted by Isard and Langford [1969], who simulated the impact of Vietnam War expenditure on the Philadelphia economy; Warf and Cox [1989] studied the metropolitan area of New York City; and Hughes, Holland, and Wandschneider [1991] examined the state of Washington, which hosted naval shipyards, aircraft industries, and other military facilities. Hughes, Holland, and Wandschneider [1991] estimated that, in the 1980s, about 6.3 percent of the total employment of the state (military jobs excluded) was supported by the military complex. Those indirect and induced jobs were mostly in services provided to households, naval shipbuilding, and the aerospace industry. In the US, IOMs have progressively been standardized to be considered as “turn-key” models (see, for example, Kriesel and Gilbreath [1994] or Warf [1997] for such “direct” applications).

In the UK, in the early 1970s, Stone [1973] mentioned that calculations made with such models found that “the relevant multiplier for jobs on defense contracts in industry was about 2.3 (1.3 indirect jobs for every direct one)”. In a study about the Devonport Dockyard, Bishop [1992] concluded that “local supply linkages were important but primarily involved services.” Several years later, Bishop et al. [2000] would set up an IOM to exactly measure those linkages. Asteris et al. [2007] studied the naval base of Portsmouth that hosted 60 percent of the Navy and employed about 8,000 (both military and civilian). They showed that, between 2003 and 2004, “the respective values of the output and employment multipliers generated were 1.55 and 1.44. Overall, maritime defence was responsible for 6% of total sub-regional employment and more than 5% of sub-regional output.”

In an ensuing study by the Center for Local and Regional Economic Analysis of the University of Portsmouth [2007], it was shown that the Portsmouth Naval Base (PNB) supports about 35,000 jobs in the region (comprising roughly 8 percent of total regional employment), of which about 24,300 are directly related to the PNB and the Ministry of Defense, while the rest is the result of economic linkages via household and supply-chain expenditures. Moreover, the model allowed the authors to estimate defense-related employment variations in response to changes in naval activity.

The Fraser of Allander Institute [2009] assessed the economic impacts of BAE Systems Surface Ships on Glasgow, Portsmouth, and Bristol. They noted that the BAE's 3,404 employees of Govan and Scotstoun in Glasgow supported an additional 4,660 jobs in the UK between 2008 and 2009 (employment multiplier value of 2.37). Portsmouth's 3,099 employees and Bristol's 198 employees supported 3,218 and 325.9 additional jobs across the UK, respectively (employment multiplier values of 2.04 and 2.65, respectively).

In France, Aben [1981a] estimated the part of employment generated by defense activities. He discovered that defense settlements helped regions with economic difficulties in the 1970s. Fas [1999] measured the impact of the professionalization of the French army on the Languedoc-Roussillon economy. The results of her study showed that the reform had a positive effect on the economy, since one franc spent by the French army within the region led to an increase of about 1.54 franc of the regional product. Meanwhile, Catin and Nicolini [2005] built an IOM based on the intermediate consumption of the DCN Toulon (*Direction des Constructions Navales*), a French military shipyard in Toulon, south of France. They estimated an income multiplier of 1.23 and an employment multiplier of about 1.2. They compared the values of their multipliers with the results of Fas [1999] and attributed the lower values to the shipyard itself (the shipyard imported 75 percent of its intermediate products) and to the size of the assessed area (the Var area is smaller than the region of Languedoc-Roussillon).

Although such models are considered to be appropriate for regional studies, they also have limits. First, many economists consider the assumption of the linearity of the production function to be rather restrictive, that is to say, "it implies a strict proportional relationship between input coefficients and output. This may be regarded as being acceptable in some producing industries but it is more questionable in the household sector, where income coefficients are average propensities, employment coefficients reflect average labour productivity rates and household consumption is determined by average expenditure patterns" [West 1995].

Second, even if IOMs are often considered to be *the models*, they clearly do not account very well for business links and networks, i.e., technological and non-pecuniary externalities, "that may be of economic significance, such as the transmission of knowledge and informal co-operation" [Bishop et al. 2000], the latter of which is related to the difficulty of incorporating

technical progress in the model with changes in the technical coefficients. Moreover, in IOMs, pecuniary externalities are not considered. Such models focus on linkages between firms and sectors, but the use of fixed technical coefficients means that IOMs do not capture changes in purchasing or selling patterns that might be expected over time.

Third, since IOMs were initially developed to analyze industrial economies with an emphasis on manufacturing, their application does not appear to be as effective in contemporary economies, where services play an important role.

Fourth, the use of IOMs may not be technically possible or financially worthwhile for assessing economic activities at regional levels. These models require detailed data, which are not immediately available, such as inter-industry data or inter-regional trade data. For example, in Languedoc Roussillon (South of France), Fas [1999] mentioned the absence of cross-industry accounting at the subnational level. In this sense, “the principal obstacle to input–output analysis is the lack of quality input–output tables at a local or regional level” [Bishop et al. 2000], and building such a model often requires a significant investment [Martin 2010].

Finally, the validity of IOMs in reflecting the underlying interdependencies in the economy rests on the assumption of stable technical coefficients over time. However, while this assumption is often made, and is likely to be satisfied in the short to medium terms, it may not be the case for longer periods. Bezdek [1984] raises this issue quite early on.

Alternative approaches to build IO tables are, of course, available, but they are generally considered to be inferior to the quality of survey-generated IO tables available in national accounting [Richardson 1985]. Parai et al. [1996] also admit “that alternative analytical approaches to IOMs are often required.” Among these approaches are non-survey methods. This reflects the substantial data requirements of the technique and the prohibitive cost of data collection to build the matrix of technical coefficients, which then has to be regularly updated to reflect changes in the structure of the underlying economy.

2. ECONOMIC-BASE MODELS

Beginning with the work of Sombart [Krumme 1968], economic-base models have been used to assess the effect of exogenous expenditure on a given area on various scales (city, local community, region, and sometimes even country). These models aim at identifying and assessing what proportion of regional output or employment is dependent on exogenous expenditure. In these models, base activities influence the development of the area with a consequent effect on non-base activities [Hoyt 1954, 1961; Tiebout 1962].

The theory separates the economy into two components: (1) activities that satisfy demands from outside the region (the “export base”), and (2) activities that mainly supply goods and services to local residents. In such models, the economic output of an area is divided into

output sold outside the area and output absorbed internally [Sirkin 1959]. Basic activities are often identified as export activities [North 1955] (e.g., industries and tourism) and governmental activities. In EBMs, nonbase activities are local (e.g., services to households) [Hoyt 1943].

Following Fujita, Krugman, and Venables [1999], Y is the total regional income and X is the income from base activities (exogenous). A share α is spent locally in the regional economy in nonbase products. Thus, if we consider several cycles of local expenditure and λ is the basic income regional multiplier, then

$$Y = \frac{1}{1-\alpha} X \Leftrightarrow Y = \lambda X \text{ with } \lambda = \frac{1}{1-\alpha}.$$

In most cases, data on income are not available. EBMs are instead implemented using data on employment. Following Camagni [1992], the economic base model in terms of employment can be written as follows:

$$E_t = E_b + E_{nb},$$

where E_t is the total employment, E_b is the basic employment, and E_{nb} is the nonbase employment within a region. If we first assume E_b to be constant in the short run, then

$$E_b = \bar{E}_b$$

$$E_{nb} = zE_t,$$

with z defined as the share of nonbase employment in total employment within the region ($0 < z < 1$). By substitution, we can write

$$E_t = \bar{E}_b \frac{1}{1-z}.$$

If the demand for basic goods (such as defense activities) increases, the resulting change in basic employment leads to a change in both nonbase and total employment:

$$\Delta E_t = \Delta \bar{E}_b \frac{1}{1-z}.$$

Finally, the basic multiplier λ_E of employment can be written as follows: $\lambda_E = 1/(1-z)$.

Studies using EBMs, assuming the stability of the base multiplier, give results such as “an increase of one job in the economic base leads to an increase of λ_E jobs in the total employment within region.” On this basis, more refined models with population growth [Hoyt 1961], the role of export [Tiebout 1962], or time-series analysis with lag variables [Czamanski 1965] can be found in the existing literature.

In the case of California, Hansen and Tiebout [1963] estimated regional and sectoral employment multipliers with an in-house model explicitly inspired by an EBM. “The level of economic activity within a regional economy can be viewed as a function of forces operating within and without that economy. By and large, the external forces give rise to greater fluctuations in

the level of economic activity...federal spending, especially in defense leads to significant changes in output and employment.”⁵

For Hawaii, Sasaki [1963] showed that “an increase in the number of people employed in the defense sector of 100 employees will lead to a further increase in total employment in Hawaii of 28 employees.” Hence, the estimated employment multiplier is 1.28. He estimated a time-series model with lag variables, and concluded that “the effect of an increase or decrease in defense spending on the overall economy is mostly felt within one year from the time the initial change occurs.”

Weiss and Gooding [1968] built a disaggregated EBM applied to the Portsmouth, New Hampshire area where defense facilities are located (e.g., an air force base (AFB) and a naval shipyard). The results of their study suggested that in such a small region, “a loss of [a] private export job would have a more severe impact than a loss of an equal number of jobs in a government defense manufacturing facility, and that closing or reducing the size of a nonmanufacturing base will have a less serious impact than either.” Considering three main sectors of export activity, they calculated the following employment multipliers: $k_1 = 1.8$ for the private-export industry, $k_2 = 1.6$ for the manufacturing defense base, and $k_3 = 1.4$ for the AFB. These are similar to the multipliers in an IOM, although the calculations are derived from an EBM instead.

Since the economy under study is small and rather open, “second-round import leakages” tend to reduce the size of the employment multiplier. Private export activity has a greater multiplier effect than the military base, which is quite self-sufficient and relatively cut off from the local community. For example, the multiplier for the shipyard is greater than the one for the AFB because its workforce is primarily composed of civilians, and it “provides minimal retail and service facilities for its personnel.” The authors argue that (1) the shipyard inputs are mainly specialized intermediate goods purchased outside the region, (2) about 20 percent of the shipyard employees live outside the Portsmouth region, and lastly, (3) workers of the shipyard have probably different spending habits due to their higher wages (e.g., higher propensity to import, save, or spend money outside the area).

In Arizona, Billings [1970] found a total impact of defense activities of 114,639 jobs and an economic base multiplier of employment of about 2.14 for military personnel. He compared the latter multiplier with a calculated IO employment multiplier and found a very small difference between the two values.

Erickson [1977] assessed the Badger Army Ammunition Plant in Wisconsin, focusing on activity levels in 1974. “Derived from several associated methodologies”, his own methodology is very inspired by economic-base concepts. He included the distances of the ten principal urban

⁵ We refer to Hansen and Tiebout [1963] for details on the different employment multipliers varying among sectors and regions in California.

centers surrounding the ammunition plant. It appeared that “most of the plant’s income-generating potential was concentrated in the immediately surrounding communities. Income generated in other communities approximately within the mean commuting distance falls to the range of seven to nine cents per dollar of direct regional income resulting from the plant.” The author concluded that “operating levels of the installation produce little community income-generating potential.” The study suggested that for plants purchasing few regional inputs, the “local procurement impacts will be restricted primarily to incidental purchasing in the nearest communities, while the vast majority of purchases of semi-manufactured goods and utilities will occur in both adjacent and distant metropolitan areas.”

Le Nouail, De Penanros, and Sauvin [1995] analyzed the direct, indirect, and induced employment of the military shipyard of Brest, France and its surrounding naval base. In 1995, they estimated the total employment depending on naval activities to be about 34,000, with about 22,600 direct jobs and 11,400 both indirect and induced jobs. According to the authors, every one direct job in the naval complex in Brest supported 0.5 jobs elsewhere in the region. Again in France, Catin and Nicolini [2005] estimated an economic-base multiplier for the region of Toulon. They found that in 1998, with a supplier’s dependence rate between 30 to 45 percent, about one job in the shipyard (total of 3,424) created two jobs in the local economy.⁶

In terms of the limitations associated with EBM, first, to build an EBM, regional scientists must accurately classify what activities are in the economic base and what are not. Making such a dichotomy is not easy in modern economies because many activities are both locally consumed and exported out of the assessed area (e.g., medical care and university teaching).⁷ In general, some level of arbitrariness is often required.⁸

Second, economic-base theory assumes that the income from the base sector drives the income from the nonbase sector. However, EBM, in practice, have focused on employment. Because of unavailable data, researchers have settled on estimating the employment multiplier instead of the income multiplier for which the theory was developed [Davezies 2008]

Third, the most commonly used version of an EBM often assumed local services to be locally consumed. However, due to the increasing role of services in the economy of today, such an assumption is not relevant. Services are often part of exports and do influence economic development [Hansen 1990].

⁶ Not to be excluded in this broad survey are the regional studies of INSEE (French National Institute of Statistics and Economic Studies), whose own methodologies are very much inspired by the economic-base theory (see Laganier and Gastaud [1996], Timotéo [2008, 2009], Bouffin and Dhune [2009], Kubiak and Serre [2009, 2010a, 2010b], and Panafieu and Bréfort [2009]).

⁷ For more details on how to define the “economic base,” we refer the reader to Fusao [1980], Dion [1987], and Laurent [2005].

⁸ On this, see, for instance, an illustration of the French case with the impact of naval activities in Brest [Boncoeur and Tanguy 1997].

Fourth, the dichotomy between base and nonbase activities can lead to a falsely vertical conception of regional activity. For example, nonbase activities are often considered less productive and often totally dependent on base activities (which are assumed to be “productive”). But such assumptions are not accurate, since many activities are exogenous expenditures and do not depend on the current base. Furthermore, nonbase activities sometimes drive regional economic development (e.g., retiree pensions) [Davezies 2008].

Fifth, EBM models are often used to make forecasts in the medium term. But one should not forget that they are mere static models which do not incorporate structural elements, such as firm productivity, interindustrial relations, or consumer taste [Polèse and Shearmur 2005]. More cautiously, results from an EBM should be interpreted only in the very short term.

Finally, the base and nonbase distinction is conceptually untenable when one tries to apply it not to a region in isolation but to the economy as a whole. “For the world as a whole, all goods are sold ‘locally,’ and all income is also spent locally, that is, the fundamental equation of the economic base model becomes 0/0 which is not a very helpful result” [Fujita, Krugman, and Venables 1999].

Despite all of these limitations, one has to consider that from a practical point of view, the model remains helpful in the case of smaller regions which are less diversified [Hustedde et al. 2005; Dion 1987]. It is also generally less expensive than an IOM to operationalize.

3. REGIONAL KEYNESIAN MULTIPLIER MODELS

Regional multiplier models (RMMs) go back to the work of Kahn [1931] and Keynes [1936]. The basic Keynesian model is based on the idea that part of the initial income injection will be spent in the region, which will generate additional income in that region. Part of the additional income is again spent in the region, and so the process continues. An increase in the regional aggregate demand facilitates, in turn, a supply-side response. In their basic version, those models are relatively simple and mainly static.

The main advantage of this approach is that it allows us to measure the effect on production and income of an initial injection of resources in the regional economy without the need for a regional technology matrix required in input-output models [Garrabe 2008]. In RMMs, the autonomous demand represents all the expenditure exogenous from the region. In this static framework, variations in the autonomous (exogenous) demand cause a multiplier effect on the regional income. Formally, with Y the regional income generated by an exogenous expenditure G and $n \rightarrow +\infty$:

$$Y = G + \beta G + \beta^2 G + \dots + \beta^n G$$

$$\Delta Y = \frac{G}{1 - \beta}$$

$$k = \frac{1}{1 - \beta},$$

where k is the regional multiplier; β is the share of each monetary unit spent in the region ($0 \leq \beta < 1$).

The initial expenditure is never totally spent in the region due to the leakages that reduce the multiplier effect. In the literature, those leakages are placed in two categories: (1) imports of goods and services and (2) tax and social contributions. Those kinds of leakages are incorporated in the RMM with two other specific parameters. Thus, Archibald [1967] set up a modified multiplier (k_A) which incorporates the effect of taxes and imports:

$$k_A = \frac{1}{1 - (\beta - m)(1 - t)},$$

where β is as previously defined, m is the marginal propensity to import⁹, and t is the regional propensity to tax (i.e., an estimate of the regional tax burden). Brown [1967] completed the model with the introduction of the public redistribution:

$$k_B = \frac{1}{1 - \beta(1 - m - t_i)(1 - t_d - u)},$$

where t_i is the indirect regional propensity to tax and t_d the direct regional propensity to tax. The parameter u is a leakage, as it models unemployment benefits lost due to the increase of income resulting from the multiplier effect.¹⁰

RMMs are typically used in assessing localized nonmilitary activities, especially those that are well-defined and spatially limited. For example, it has been applied to assess medical facilities [Moore 1974], nuclear plants [McGuire, 1983], a particular population, such as retirees within a region [Vollet and Roussel 2007], or public expenditures in a whole region, such as recently in Charles et al. [2013] in the Nord-Pas-De-Calais in France. Although such models are less commonly used in the case of defense activities, some studies may be cited. We present here some examples inspired by the RMM framework in a static perspective.

In the UK, in the case study of the Moray Air Stations, Greenwood and Short [1973] used a regional multiplier framework and found a value of employment multiplier between 1.7 and 1.9 [Aben 1981b]. Short, Stone, and Greenwood [1974] used it in the case of the Clyde Submarine Base, and they explain the lower multiplier effect they estimated with the following: first, military forces do not permanently reside in the region and therefore tend to spend a lower proportion of their income there; second, some military consumption is internal to the base and more related to the internal military supply chain than to the regional economy.

⁹ In practice, the “average propensity to import” is more commonly estimated.

¹⁰ More detailed models have been proposed. See Fas [1999] for an overview of the various multipliers found in the regional literature.

On the results of a number of studies conducted for defense establishments, citing his earlier work in 1992, Bishop [1994] concluded that the local income multiplier is between 1.1 and 1.4. His estimate of a multiplier of about 1.23 based on the major dockyard of Devon and Cornwall is within this range, and corresponds to one indirect job being generated by about 4.3 direct jobs. In an RAF base in Chivenor, Bishop [1994] determined that about 1,264 jobs were either directly or indirectly generated by the base, which constitutes 4.5 percent of local employment. His estimate of 1.32 as the job multiplier in this case is close to previous estimates.

For Sète in the south of France, Aben [1981b] found that “one franc spent to provide goods and services to the regiment yields to garrison town an amount between 1.04 and 1.22.” In addition, “a military job leads to a number of civil jobs between 0.6 and 0.98 in the local economy.” The method is based on a survey of the regiment’s consuming habits combined with data from local governing bodies.

Meanwhile, for the years 1986–1987, Rioux and Schofield [1990] showed that the Canadian Force Base Esquimalt (British Columbia) “generated between \$391.5 million and \$440 million in income” and about 14,400 to 16,600 jobs, which constitutes 14.4 to 16.6 percent of total employment in the local economy. Though their framework is Keynesian, the authors used economic-base concepts to calculate the average propensity to locally consume. As such, the model represents a mixture of both the EBM and the RMM approaches.

RMMs have limitations partly due to the lack of data at regional levels. The first is in the estimation of the leakages. Incorrect values for m , t_i , t_d , and u will automatically result in the wrong multiplier and will systematically bias the effect of defense activity. Some nonsurvey methods have been proposed to estimate m (see, for example, Fas [1999] or Poffet [1989]). However, the estimation of the other parameters without the use of survey methods is still very difficult, as this involves knowing precisely the population to be assessed in order to know the structure of their consumption. Such a survey is sometimes highly complicated to set up or impossible to realize (e.g., in the case of defense activities, having access to the spending structure and geographic organization of a private defense firm is a real challenge).

The second limitation is the increasing complexity related to the reliability of the model. To make the model more reliable, more statistical information is required, and this leads to a complicated RMM which may not make its application common. For example, a more complicated model will require an increase in management costs, as experts with the necessary skills will be needed to use the model and to update it further (although, to be fair, that any increase in complexity will necessitate an increase in operational costs applies also to the other methods described in this survey). These limits related to the increasing complexity partly explain the fact that most scholarly works using RMM basically examined the ratio between indirect and direct income or jobs.

Finally, if the RMM framework appears to provide a tractable approach for use in situations involving defense activities, it is necessary to caution against the simplistic application of multiplier values estimated in some studies to cases of defense activities elsewhere [Rioux and Schofield 1990]. Thus, it would be inappropriate to use the findings of a particular study as a basis for another location. Clearly, every facility and every community has its own particular spending characteristics. In the case of military bases, for example, the local impact will depend on base operations and the size of the community to which the base is located. In this respect, survey methods are clearly a recommended way to estimate the basic parameters of RMMs.

4. REGIONAL ECONOMETRIC MODELS

Econometric models developed to assess defense activities at the regional level appeared first in the US in the beginning of the 1970s to examine the economic consequences of a settlement in Vietnam [Klein 1968; Klein and Mori 1973]. Since then, different models have been proposed, tested, and discussed. Some of them have become increasingly sophisticated. In this survey, we distinguish three main families in regional econometric models (REMs).

In the first family, the national economy is modeled to analyze the impact of regional defense expenditure. Examples of such studies are those of Crow [1970] and Dunne and Smith [1984]. With national results from Klein and Mori [1970], Crow [1970] used a nationally-linked regional model to analyze the impact of alternative military expenditure policies on the Northeast Corridor regions in the US. The author built a forecasting model for the region which enabled him to simulate (1) the existing policies compared with a “peace solution” (budget cuts offset by increased civilian expenditure and lower tax rates) and (2) a “military solution” (high defense budgets with high taxes and interest rates). Dunne and Smith [1984], on the other hand, had a hybrid approach: integrating an IOM with econometric techniques. Their disaggregated model (40 industries, 49 categories of consumption, five categories of government expenditure, and four categories of capital expenditure) estimated the degree of concentration of UK defense expenditure in certain key industries and subregions.

In the second group, the models explicitly incorporate defense expenditure in a regional setting. As Braddon [1995, p. 503] explained, a satellite type of regional model was initially employed, “drawing heavily upon national econometric models.” Such models aim fitting a simultaneous-equations model where each equation takes the following form:

$$x_{it} = f(x_{jt}, y_{kt}, e_t),$$

where x_{it} is the i^{th} endogenous variable in period t , x_{jt} is the j^{th} endogenous variable in period t , y_{kt} is the k^{th} exogenous variable in period t , and e_t is the error term at period t .

This second group of econometric models has focused its attention at the regional level with two types of approaches. First, there is a Keynesian approach, where initial changes are

attributable to an increase in aggregate demand, which in turn facilitates a supply-side response. In these models, regional economic activity is divided into its component parts, with each key economic activity being modeled separately (e.g., investment, employment, and output). Second, there is an input-output approach with the analysis of interindustrial relations. Both of these approaches allow us to estimate the impact of an exogenous shock to the region's economy. Examples of such studies are those of Glickman [1971], Burton and Dyckman [1965], Klein and Glickman [1977], and Nicolini [2003].

In the third group of REMs, the models are more heterogeneous and are focused specifically on defense activities. Citing Daicoff et al. [1970], Rowley and Stenberg [1993, p. 3] note that "a study examining the 1960s found that when direct reduction of employment due to base closure was at least 5 percent of the community's population, the closure reduced overall employment in the community." Given that few examined communities reached this threshold, they concluded that there was little effect of base closure on local employment. The study concluded positively on how communities coped with base closures. The minimal change in the unemployment rate found by the authors was probably due to a combination of the transfer of military personnel (rather than its introduction into the local labor pool) and significant efforts made to relocate civilian personnel (in the regional economy or elsewhere).

In the US, Mehay and Solnick [1990] performed an econometric assessment of military expenditure at the regional level in the medium term (1976–1985), with a focus on growth and industrial employment. The results of their study show that military expenditure positively impacts regional growth. However, only investment expenditure "is positively related to personal income growth, whereas both investment and operating programs appear to influence employment growth".

Rowley and Stenberg [1993] meanwhile examined "economic changes in selected counties where one or more military bases closed during the 1960s, 1970s, and early 1980s." The authors compared metropolitan and nonmetropolitan counties where bases closed with their national means. The results show that the job loss is offset for about two-thirds of base-closing counties, and that nonmetropolitan counties are more affected by base closings than the metropolitan ones, employment growth is higher in metropolitan counties than in nonmetropolitan ones, and real income growth is weaker in nonmetropolitan counties than in metropolitan ones.

Parai et al. [1996] conducted a study that assessed the impact of 44 Canadian military bases on their regional environment using a framework that incorporated economic-base concepts with econometrics. The authors expanded the original EBM by including demographic impacts, grants, and housing-demand impacts. Thus, the model "gives an approximate indication of the magnitude of the impacts which the base has on its host community." They found that bases that are located in large host communities tend to have a small impact on the local economy.

Conversely, bases in small host communities have a large impact because of the small size of local economy. In between, a range of impacts are observed, depending on the size of base activities relative to the host community.

In the US, Krizan [1998] found that “base closures are negatively correlated with establishment net growth rates, though slightly less so in small communities.” In addition, workers’ employment prospects improve because retired personnel who settle in the area increase the demand for goods and services. He also reports that the reallocation of factors of production when bases downsize is not that significant. This is because a base closure somehow reduces the establishment birth rate, so factors do not have to be reallocated.

Again in the US, Hooker and Knetter [1997] focused on the relationship between defense procurement spending and employment growth rate across states, for which they found no significant relationship. Moreover, procurement cuts only reduced national employment growth rate by “about one tenth of a percentage point.” Finally, they found a nonlinear relationship between the variables, suggesting that large negative procurement shocks cause proportionally larger decreases in employment growth rate. They suggest that the use of linear relationships between military expenditures and short-run economic activities probably “underestimate the impact of defense drawdown when the drawdown is concentrated in time or space.” Subsequently, Hooker and Knetter [2001] analyzed the effect on employment and personal income resulting from the closure of military bases during 1971 and 1974 at the county level. They found both employment and income multipliers to be less than 1. Moreover, they showed that “employment costs are limited to the direct job loss associated with military transfers out of the region and per capita income is little affected by closures on average.”

Meanwhile, Poppert and Herzog [2003] examined the indirect effect of military installations on county-level private employment. They focused on special cases of the base closure under several rounds of the BRAC process. In the long run, they find that the BRACs increased employment, likely due to the BRAC-related federal assistance packages. In the medium term, they observe positive indirect employment effects, attributed to the self-sufficient nature of military bases and the composition of the civilian workforce. Land and infrastructure conversion from military to civilian use entailed indirect effects on private employment as well, and such effects are dependent on how rapidly the assets are transferred to their new civilian owners.

In Sweden, Andersson et al. [2007] made use of a data set of 31 municipalities covering the period 1983–1998. They noted that “a closure of a base has not had any significant impact on the subsequent average income growth rate nor the net migration rate in the affected municipalities.” To explain their results, the authors postulated that the former employees at the military bases have found new employment within the region (in the private or the local public sector). Their analysis suggests a kind of resilience of the local labor market after an exogenous shock.

As such, they argue that the need for a public policy for compensating affected communities is not obvious.

In Germany, Paloyo et al. [2010a] studied 298 communities for the period 2003–2007. They found that base closures have had no significant socioeconomic impact on the surrounding communities. Such results are due to the small size of German bases and the economic autonomy of most bases. Furthermore, a number of former bases were rapidly reused for civilian purposes (e.g., hospital complex and tourist attraction). Such development projects presumably induced a substantial increase in tax revenue. In a further study [Paloyo et al. 2010b], the authors estimated the impact of the base closures in Germany on the intensity of criminal activity surrounding military bases. Apart from confirming existing findings in the literature on the determinants of crime, their results indicated that the base closures had no effect on the criminal activity surrounding the bases. The results strongly suggested “that base closures or the reallocation of military personnel across bases will have no effect on the crime level in the communities affected.”

Exploiting the regional variation in defense expenditure within Switzerland, Bernauer et al. [2009] show that cantons which have a larger share of their labor force related to defense employment show a more stable unemployment rate. Defense spending, however, does not seem to have an impact on regional GDP growth. They also estimate a national time-series model, where they show that defense spending as a percentage of GDP contributes to positive economic growth during times of “high external threat”.

Labor-market studies, which are typically econometrics-based, may also provide some insight on the adjustment processes when it comes to examining the impact on employment, wages, and transitional aspects of the labor market. When plant closures may be regarded as exogenous changes to labor demand, one could estimate its impact of employment probabilities within the periphery. The speed of adjustment of the labor market may also be measured, and this informs on whether the market is flexible or if there are rigidities in the labor market that result in either market failure or slower adjustment toward the new equilibrium. Moreover, the exogenous change in labor demand may also be exploited to examine other outcomes that are interesting, such as physical and mental health of the workers (e.g., Browning and Heinesen [2012]).

5. CASES STUDIES AND MONOGRAPHIC APPROACHES

In this survey, we define a research monograph as the study of a specific phenomenon limited to a given area. This methodology is typically characterized by data collection, fieldwork with direct observations, and sometimes interviews with local key informants. A research monograph aims at fully presenting and describing features of the phenomenon that economic modeling and econometric estimations, with their emphasis on averages, may fail to take into account. Such a

method is more attuned to describing qualitative features of a specific case, and may contribute to a better understanding of the phenomenon in question.

Examples of this are the works of Breheny [1988], which collected papers related to the regional impact of defense activities, Paukert and Richards [1991], which focused on the labor-market impact related to changes in defense activities, and De Penanros [1995], which collected papers related to defense conversion with a regional focus. Additionally, one may also think of supply-chain analysis for a particular industry or product (e.g., for armored fighting vehicles [Hartley et al. 1997]).

There are numerous published case studies, and we propose a basic analytical framework to understand what we can learn from monographic studies about the impact of defense activities on their regional surrounding communities. We also describe the limitations of such a methodology.

Due to a complex nexus of historical, strategic, and economic reasons, military expenditure is unevenly distributed among and between national economies and regions [Short 1981; Lovering 1991; Atkinson 1993; Bishop and Gripaios 1995] as are the income and employment effects [Southwood 1985]. Defense activities structure, and sometimes create, microspatial patterns, such as cities [Bateman 1987; Jovanovic 2001]. Aside from these, however, they also structure macrospatial patterns. In fact, the work of regional researchers shows they tend to agglomerate and make specific spatial patterns (e.g., “gunbelts” in the US [Markusen et al. 1991], “islands of prosperity” in the UK [Lovering and Boddy 1988; Law 1983]). Those kinds of activities also artificially divide countries [Boddy 1988; Bishop and Wiseman 1999] with the creation of ex nihilo “military enclaves” [Markusen and Park 1993].

Defense activities deeply influence the structure of regional economies in cases where defense activities contribute to regional income and skills. For example, during the 1970s and 1980s, in most Western countries, many regions benefited from the economic consequences of increasing defense expenditure (e.g., Southwest of France, South of Germany, Southwest of England). Unsurprisingly, those effects depend on the size of the military complex and defense facilities. Case-study approaches are relatively abundant in this literature.

Research by Malecki [1981] and Markusen [1984] has pointed to the importance of military expenditure in underwriting regional growth in high-technology industries. Regional case studies have been conducted for Canadian defense industries in the case of Quebec [Belanger 1990, 1993]. Similarly, in the UK, most of the studies conducted pointed to the importance of the military’s outlay of money and goods in subsidizing regional growth, also especially in high-technology industries (e.g., Todd [1980]). The effect goes beyond the quantitative aspects of defense expenditure and underlines the qualitative ones suggesting that “the regions within a

country which are able to capture the new technology are most likely to be able to maintain relatively high incomes and high levels of employment” [Law 1983, p. 182–183].

For further details related to those qualitative changes, one can refer to the work of Hicks and Raney [2003] that presents an interesting case study of two counties in the US. Adopting a comparative experimental methodology, the authors examined the structural changes caused by a naval base on a community in the long run (50 years). Finally, the role played by military expenditure in development policies has also been discussed [Stein 1985].¹¹ In the same spirit, the study of Barber [1996] focused on the importance of indirect effects of an increase in military activities, especially for isolated regions such as Darwin (North of Australia).

Nonetheless, defense activities sometimes weaken regional economies. For example, some case studies of “one-company towns” revealed that the defense industry sometimes dominated labor markets with a “lock-in effect”. Some examples of this are the “shipyard towns,” such as Barrow-in-Furness in the UK with the Vickers Trident Submarine Works (now owned by BAE Systems) [Grime 1987], Plymouth with the naval base [Gripaios and Gripaios 1994], and Mare Island in California, USA with the former naval base [Schneider and Patton 1988]. This exclusive dependence on the defense infrastructure may prevent the diversification of regional economies. In the case of Plymouth, for example, Bishop [1988] argued that defense spending was an important factor in the strength of the retail trade in the city in contrast to the fairly underdeveloped business service sector. Bishop and Gripaios [1995] looked at the effect of the decline in employment for the Devonport Dockyard, which affected the counties of Devon and Cornwall. Schneider and Patton [1988] reached the same conclusion for the county of Vallejo in California.

Such economic dependence has led to the extensive study of defense conversion following defense cutbacks at the beginning of the 1990s [Fontanel 1994]. Following Gansler [1995, p. 70–71], defense conversion can be defined as all initiatives that “include changes in the economic base where the major employer was a defense firm or a defense facility, the restructuring of a formerly defense-dominated corporation, or the reorientation, at plant level, of the facility or the work force.”

In terms of conversion, case studies often focused on how regional and local communities responded to the withdrawal of the army or the military cutbacks and their consequences for the regional economy. In Europe, in response to the strong dependence of some European regions, the literature naturally focused on the defense conversion process, such as in 1992, when the European Commission studied regions’ dependence on defense activities in a comparative perspective [Commission of the European Communities 1992].

¹¹ See the work of Lovering [1985] for an interesting case study of the Bristol subregion compared with South Wales.

Various case studies also covered the conversion of military bases or defense industries and regional resilience. In the US, Lynch [1970] examined 12 communities making the transition, i.e., before and after a base closure; MacKinnon [1978] studied the economic progress of seven communities located near AFBs that closed in the mid-1960s; Dardia et al. [1996] presented three regional case studies in California; Soden et al. [2005] proposed three case studies in New Mexico; and Bradshaw [1999] examined the impact of the Castle Air Force Base closure in California. In the UK, Braddon and Dowdall [1996] reported on the restructuring of the regional defense industrial base in the case of the South West. In 2000, Pike, Cornford and Tomaney examined the Swan Hunter Shipyard in the UK. Their survey focused on the workers who were made redundant. Their results “confirm the complex but generally negative effect of redundancy on the workers involved”. Focusing on Brest (France), Le Nouail and Sauvin [1996] highlight the role of local communities and projects in the success of the conversion process. They particularly focus on the importance of the transferability of local abilities and knowhow from military production to a civilian one. Within this framework, Sauvin [2000] goes further and examines the possible conversion from military production in Brest (military ships) to civilian oil platforms. For Germany, Central and Eastern Europe, as well as Russia, among other places, the Bonn International Center for Conversion is a valuable resource as researchers based in BICC have extensively written on particular cases of conversion.¹²

For a more thorough discussion around regional conversion processes, the book of De Penanros [1995] is very useful. This original collection of papers gathers writings of specialists around this topic. It provides an overall view of issues related to the regional industrial defense conversion process with three levels of focus: first, a comparison between the US and Russia; second, a European perspective; and third, a study of the French case. Finally, with respect to conversion in Europe, one can also refer to Hooper and Cox [1996] for industrial case-studies within the framework of the European Union Konver Programme, and Frigant and Jullien [2010] for a comparison of the use of Konver Programme funds between three European regions: Lombardia (Italy), Manchester (UK) and Aquitaine (France).

Case studies might be very useful for the public planner. First, they establish details and qualitative elements that a more standardized model cannot uncover (e.g., the key role of local actors, strategic and political sides of military settlements, and changes in military technology). Moreover, as they are close to ethnographic methods, they are a very useful tool to describe local consequences of big transitions (e.g., the transition to the post-Soviet era and the end of the Cold War, the transition to a market-oriented approach in armament production for some countries, such as France, or the role of the State in defense conversion [De Penanros and Serfati 2000]).

¹² The various publications of the BICC are available from their website: <http://goo.gl/NVsoh0>.

Case studies also provide useful information on the dynamism of regional economies in response to changes in defense expenditure flows. Due to their typical emphasis on qualitative analysis, such studies often provide information pertaining to the relationship between actors in a bottom-up movement. From a practical point of view, with relatively little time spent in the field, they can bring useful information to decision makers.

Though monographs provide a useful learning exercise about the range of impacts to be expected at the regional level in various dimensions with an emphasis on its qualitative aspects, they are “idiosyncratic,” i.e., related to the place they have been set up. Their results are contingent on the place and time of the study. They cannot be expected to generate outcomes that are universally relevant.

Moreover, they are dated, as we note that most of the case studies that have been published are set around the time the USSR disbanded. They do not distinguish military activities from civilian activities. This is not relevant today because of both the specialization of the armed forces (i.e., professional armies) and the unbundling of military activities, especially in defense support (e.g., outsourcing and public-private partnerships).

Keeping in mind the limits mentioned above, we can make some recommendations on when a case study might be appropriate. Case studies might be useful *ex ante*, i.e., when regional practitioners start assessing the defense activities of a region (for example, those facing defense cutbacks). Indeed, the fieldwork associated with case studies leads to a better knowledge of the relation between regions and defense activities. As a consequence, the acquisition of empirical data is facilitated, which is a crucial condition to go further in assessing the defense dependence of a region.

Case studies might also be useful *ex post*. For example, when cutbacks, base closures, or troop withdrawal has occurred, regions need a strategy for facility conversion. A research monograph could be advantageous in identifying the factors contributing to the success or failure in the local redevelopment of former defense sites.

CONCLUSION

In defense-dependent regions, defense cutbacks, base closures, or downsizing of defense-related facilities could potentially affect regional economic activity. As a result, regional policymakers often try to assess, and possibly mitigate, the economic impact of defense drawdowns and intensifications.

This rise and fall of interest on this topic is related to macrophenomena that have an impact on regional economies. For example, studies assessing defense activities were numerous immediately after the Cold War (see Braddon [1995]). The current context of cutbacks in defense expenditure—partly caused by the sovereign debt crisis and more generally by public def-

icits—also stimulates many regional studies about defense activities and their economic contribution to regional development.

As such, we believe that it is useful to review the past literature to fully account for the varied potential ways one could undertake such an analysis for the benefit of both policymakers and stakeholders. When we speak about regional policy and regional assessment studies, we typically speak about public (i.e., tax-raised) money. Indeed, an overall view with a cost–benefit orientation might be useful for transparent governance and accountability.

With this perspective, we examined the most widely used methods found in the academic literature to assess the regional impact of defense activities. Our survey provides a helpful tool for local public institutions facing nonlocal decisions related to defense activities. It may be seen as a practical starting point which we hope will be useful to those interested in assessing defense activities in their surrounding environment (e.g., city and regional authorities).

To date, there is no current standard method for analyzing the impact of defense activities on regional economies. Although we attempted to provide an exhaustive classification of typical methods applied in this context, there are some that are not mentioned above but have been applied as well, though not as common as those methods we covered (e.g., Solomon [1996] and his application of integer-programming methods in Canada). There is also an abundance of nonacademic work on the topic, which typically features the lack of any clear theoretical framework. This conspicuous gap does not help policymakers at all. This problem is partly caused by methodological difficulties, such as the lack of knowledge about military institutions and the available data, or the lack of expertise in regional statistical analysis.

In aid of policymakers and other researchers, we presented a methods-based typology of the literature in regional economics. A listing of these studies is presented in the appendix as Table 1. In order to identify and clarify the different models existing in the literature, we detailed the historical and theoretical background of each method, as well as selected exemplary cases where these methods were applied. Also available in the appendix is a summary of the estimated multipliers in the studies covered by this survey (Table 2).

Broadly, we have identified five common methodological approaches in the literature thus far: input–output models, economic-base models, regional multiplier models, econometric models, as well as case studies or monographs. Each method has its own strengths and weaknesses, and we believe that only in combination can they provide a full picture that is of most use to policymakers and the affected communities.

In future work, one should address the limitations of the methods outlined here. For instance, these models and estimation frameworks do not typically allow for the dynamic aspect of changes in the defense structure of the local economy. The models are more static than dynamic, and any equilibrating processes that the economy might undergo are not usually modeled. One

way to move forward is perhaps the use of error-correction models in time-series data to at least capture some transition dynamics.

As a final note, we mention that, despite the diversity of available methods, a cross-cutting limitation is the absence of good data. Since the industry is sensitive to national security concerns, it may be in the best interest of the state to suppress the publication of data concerning military bases and the military infrastructure within the nation. For instance, the state may not disclose the exact location of military bases across the country even though matching these bases to regional developments would necessitate the use of some spatial information. Moreover, even if national security were not a concern, the collection and storage of data concerning the military infrastructure may not be given the appropriate attention for whatever reason, chief of which is perhaps the fact that the principal concern of the defense and military establishment is national security and not the employment stability of civilians surrounding the base.

However, in terms of being able to inform on policy (for instance, on what sort of support mechanism works in cushioning the impact of a massive drawdown of military services on, say, employment in an isolated region), accurate information and credible evaluation are necessary. For situations where national security is not threatened by the collection and publication of data on these issues, the government should consider a system where the information may be provided at low cost to enable researchers and policymakers to assess and mitigate potential negative impacts from changes in defense-related parts of the economy.

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Appendix

Table 1: Summary of the main models found in the literature

Framework and selected papers	Strengths	Weaknesses	Principal Requirements
IOM			
Aben [1981a]; Asteris et al. [2007]; Bishop et al. [2000]; Catin and Nicolini [2005]; Center for Local and Regional Economic Analysis of the University of Portsmouth [2007]; Fas [1999]; Fraser of Allander Institute [2009]; ; Hughes, Holland, and Wandschneider [1991]; Isard and Langford [1969]; Kriesel and Gilbreath [1994]; Leontief et al. [1965]; Leontief and Hoffenberg [1963]; Moore and Petersen [1955]; Stone [1973]; Warf [1997]; Warf and Cox [1989]	<ul style="list-style-type: none"> - Divided view of the regional economy - Pervasiveness in economic literature - Precise identification of economic sectors that drive the results 	<ul style="list-style-type: none"> - Has difficulties taking into account changes in technology (technology matrix) - Building the regional table is time-consuming - If the model is employed when a regional table does not exist, sensitive assumptions are often needed to build a regional table. - High cost to update the table 	<ul style="list-style-type: none"> - Access to regional tables, either to be generated or taking what is already available - If generating a new table, consistent accounting between districts is necessary, although this may not be available.
EBM			
Billings [1970]; Boncoeur and Tanguy [1997]; Bouffin and Dhune [2009]; Catin and Nicolini [2005]; Erickson [1977]; Hansen and Tiebout [1963]; Kubiak and Serre [2009, 2010a, 2010b]; Laganier and Gastaud [1996]; Le Nouail, De Penanros, and Sauvin [1995]; Panafieu and Brefort [2009]; Sasaki [1963]; Tiebout [1963]; Timotéo [2008, 2009]; Weiss and Gooding	<ul style="list-style-type: none"> - Low in cost - Well-regarded in the literature - Likely more applicable in smaller and more specialized economies 	<ul style="list-style-type: none"> - The model needs conventions or rules, since the way the modeler defines base and nonbase activities is often subjective. - The distinction between base and non-base activities is often difficult to make in modern economies. 	<ul style="list-style-type: none"> - Assessing a small, well-defined area, particularly on variables such as employment and income - Focusing on income if data exist; if not, employment is the default fallback option

[1968]

RMM

Aben [1981b];
Bishop [1992];
Bishop [1994];
Greenwood and Short
[1973];
Rioux and Schofield
[1990];
Short, Stone, and
Greenwood [1974]

- Multiplier framework allows the estimation of the broader impact of defense expenditure
- Relatively easier way to compute full employment impacts

- The estimation of the basic parameters in the model often requires complicated econometric investigation.

- In practice, the "average propensity to import" is more commonly estimated.
- Appropriate regional accounting methods are necessary to compute the marginal propensity to import, among other parameters.

EM

Bernauer et al. [2009];
Browning and Heinesen [2012];
Burton and Dyckman [1965];
Glickman [1971];
Klein and Glickman [1977];
Mehay and Solnick; [1990];
Nicolini [2003];
Paloyo et al. [2010a]
Paloyo et al. [2010b]
Rowley and Stenberg [1993]

- Flexible with the outcome variable of interest, such as crime and educational outcomes

- Typically used only for ex-post analysis

- An assortment of data requirements necessary to estimate the model
- Econometrics may not be the easiest subject to explain to a policymaker, hence, partnerships with research institutes and universities may be necessary.

Monograph/Case study (Selection of papers or books)

Belanger [1990];
Bishop and Grippaios [1995];
Bonn International Center for Conversion (BICC) studies;
Bradshaw [1999];
Breheny [1988];
Dardia et al. [1996];
De Penanros [1995];
Lovering [1985, 1988, 1991];
Lynch [1970];
MacKinnon [1978];
Markusen [1984];
Paukert and Richards [1991];
Schneider and Patton [1988];
Soden et al. [2005]

- Qualitative view of problems and changes often hidden by more formal models
- Could be taken as a preliminary step toward a more formal assessment (e.g., with another model, such as an EBM or IOM, or using econometrics)
- Allows the identification of key institutions and individuals

- Idiosyncratic
- Can deemphasize generalized effects and concentrate too much on the specific case without general applicability

- Making many interviews in various places for an in-depth view of the problem
- Good knowledge of the region at the beginning of the study (in order to avoid the waste of finances)
- Illustrating the case study with data about employment or income (e.g., share of defense-dependent employment, nature of firm activities in the region)

Source: Authors' representation.

Table 2: Explicit multipliers values of the main models found in the literature

Selected papers	Country	Multipliers values
Input-Output Models		
Asteris et al. [2007]	UK (Portsmouth)	Economic impact of Britain's Royal Navy and associated defense activities in the City of Portsmouth and its surrounding area. - <i>Overall output multiplier</i> : 1.55 - <i>Employment multiplier</i> : 1.44
Bishop et al. [2000]	UK (Plymouth)	Economic impact of Devonport naval base/dockyard complex. - <i>Income multiplier</i> : 1.17 - <i>Employment multiplier</i> : 1.22
Catin and Nicolini [2005]	France Var (south of France)	Economic impact of DCN Toulon (<i>Direction des Constructions Navales</i>), military shipyard in Toulon, south of France. - <i>Employment multiplier</i> : 1.166 - <i>Income multiplier</i> : 1.23
Fas [1999]	France Languedoc Roussillon (south of France)	Impact of the professionalization of the French army on a French region: the Languedoc Roussillon (south of France). - <i>Regional Production Multiplier</i> : 1.54
Fraser of Allander Institute [2009]	UK (Glasgow, Portsmouth, Bristol)	Economic impact of BAE Systems Surface Ships (formerly BVT Surface Fleet) in Glasgow, Portsmouth, and Bristol. Glasgow (impact on the UK) - <i>Employment multiplier</i> : 2.37 - <i>Wage income multiplier</i> : 2.20 - <i>Gross value added multiplier</i> : 2.56 Portsmouth (impact on the UK) - <i>Employment multiplier</i> : 2.04 - <i>Wage income multiplier</i> : 2.07 - <i>Gross value added multiplier</i> : 2.76 Bristol (impact on the UK) - <i>Employment multiplier</i> : 2.65 - <i>Wage income multiplier</i> : 1.96 - <i>Gross value added multiplier</i> : 1.73
Kriesel and Gilbreath [1994]	US (Georgia)	Local economic impacts from deploying 1,000 troops for one year, Fort Stewart and Hunter Army Airfield (1991 \$): - <i>Total gross output multiplier</i> : 1.2258–1.6688 - <i>Wages and salaries multiplier</i> : 1.1924–1.8131 - <i>Total income multiplier</i> : 1.2221–1.64849 - <i>Value-added multiplier</i> : 1.2255–1.6948 - <i>Employment multiplier</i> : 1.1570–1.5465
Stone [1973]	UK (several regions)	Defense contracts in industry in several regions. - <i>Employment multiplier</i> : 2.3 (1.3 indirect jobs for every direct one).
Economic-base models		
Billings [1970]	US (Arizona)	Measuring the impact of defense spending in the economy of Arizona. Economic base model: - <i>Employment multiplier</i> : 2.14 - <i>Income multiplier</i> : 2.29 The author compares those values with input-output results: - <i>Employment multiplier</i> : 2.24 - <i>Income multiplier</i> : 2.44
Bouffin and Dhune [2009]	France Paris	Regional study of INSEE. Economic impact of a French Air Force Base and a logistics regiment. - <i>Employment multiplier</i> : 1.20

Catin and Nicolini [2005]	France Var (south of France)	DCN Toulon (<i>Direction des Constructions Navales</i>), military shipyard in Toulon, south of France. - <i>Employment multiplier</i> : 1.82–1.99
Erickson [1977]	US (Wisconsin)	Economic impact of Badger Army Ammunition Plant (activity level of 1974), for 10 zones surrounding the plant. The author calculates the additional income generated at the sub-regional level. So, the multiplier estimates are based on 1 plus the additional income generated at the sub-regional level. - <i>Sub-regional impact multiplier</i> ranges from 1.008 to 1.355.
Kubiak and Serre [2009]	France Lorraine (north east of France)	Regional study of INSEE. Economic impact of a military regiment which was closed in 2011. - <i>Employment multiplier</i> : 1.34
Kubiak and Serre [2010a,b]	France Metz (east of France)	Regional study of INSEE. Economic impact of a French Air Force Base (closed in 2012). - <i>Employment multiplier</i> : 1.43
Laganier and Gastaud [1996]	France Plateau d'Albion (south of France)	Regional study of INSEE. Economic impact of plateau d'Albion, a former nuclear ballistic missile site in France, which was closed in 1996. - <i>Employment multiplier</i> : 1.36
Le Nouail, De Penanros, and Sauvin [1995]	France (Brest)	Economic impact of defense naval complex (Navy and military shipyard). <i>Employment multiplier</i> : 1.5
Panafieu and Brefort [2009]	France Marne	Regional study of INSEE. Economic impact of a French Air Force base (closed in 2011). - <i>Employment multiplier</i> : 1.34
Sasaki [1963]	US (Hawaii)	Economic impact of changes in military spending on the Hawaiian economy. - <i>Employment multiplier</i> : 1.28
Timotéo [2008]	France Barcelonnette (south of France)	Regional study of INSEE. Economic impact of a military training center, which was closed in 2009. - <i>Employment multiplier</i> : 2.56
Timotéo [2009]	France Briançon (south of France)	Regional study of INSEE. Economic impact of a military training center (closed in 2009). - <i>Employment multiplier</i> : 1.71
Weiss and Gooding [1968]	US Portsmouth (New Hampshire)	Impact of defense facilities (e.g., an air force base and a naval shipyard) on the Portsmouth area (New Hampshire). - <i>Employment multiplier</i> (private export industry): 1.8 - <i>Employment multiplier</i> (manufacturing defense base): 1.6 - <i>Employment multiplier</i> (Air Force Base): 1.4

Regional Keynesian-multiplier models

Aben [1981b]	France Sète (South of France)	Economic impact of an infantry regiment in the city of Sète. - <i>Employment multiplier</i> : 1.6–1.98 - <i>Income multiplier</i> : 1.04–1.22
Bishop [1992]	UK	Several studies conducted for defense establishments - <i>Local income multiplier</i> : 1.1–1.4
Bishop [1994]	UK (Chivenor)	Economic impact of a RAF base in Chivenor. - <i>Employment multiplier</i> : 1.32

Greenwood and Short [1973]	UK (Scotland)	Economic impact of the Moray Air Stations, Lossiemouth, Moray, Scotland. - <i>Employment multiplier</i> : 1.7-1.9 Cited by Aben [1981b]
Rioux and Schofield [1990]	Canada CFB Esquimalt (British Columbia)	Economic impact of the Canadian Force Base Esquimalt in British Columbia, Canada. - <i>Employment multiplier</i> : 1.86-2.15 - <i>Income multiplier</i> : 1.64-1.86

Source: Authors' representation. Studies with no explicit multiplier values reported or where it is not possible to calculate it ourselves are not included in the table.